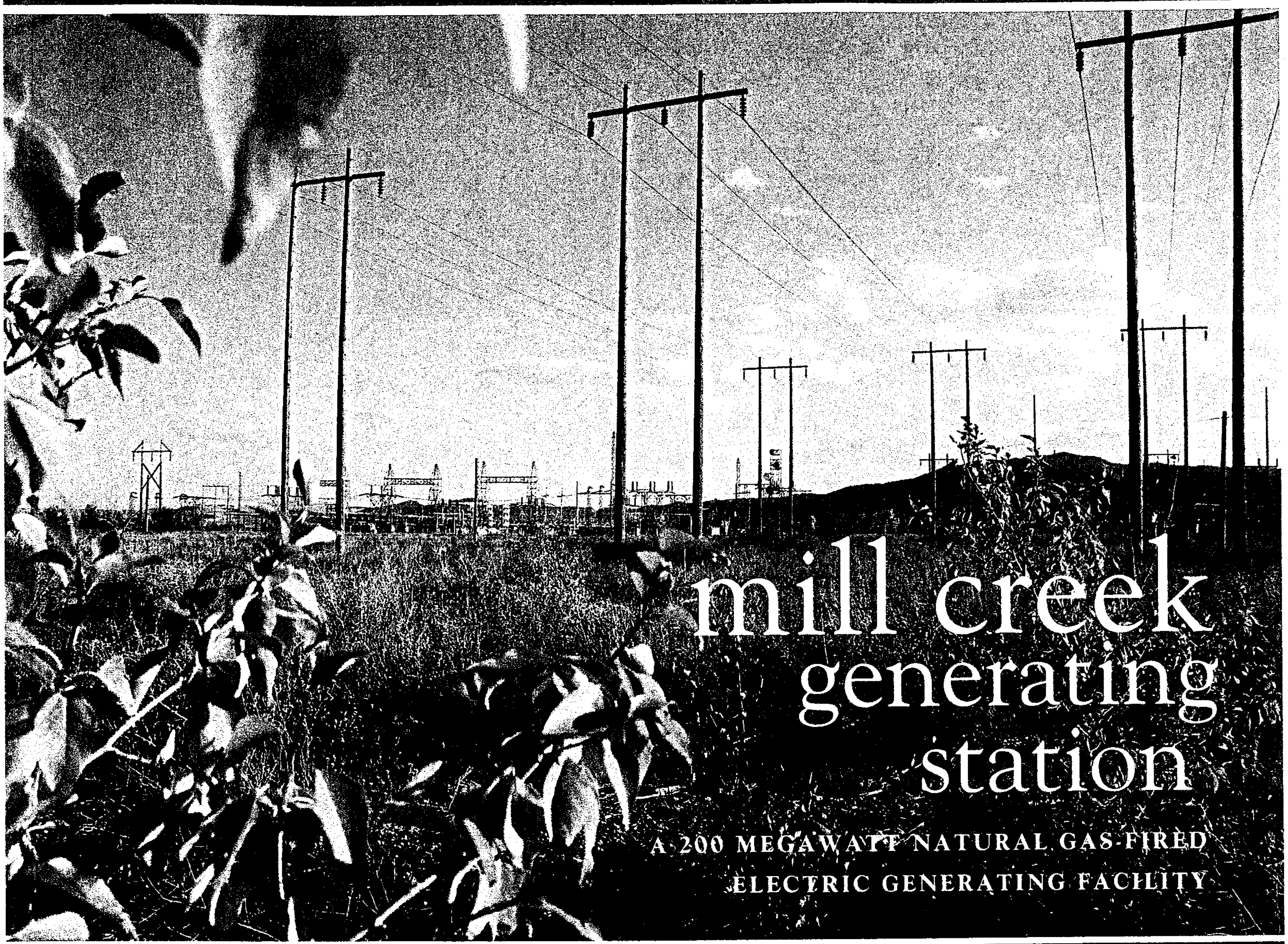
Senate Energy & Telecomm.Comm.
Exhibit No. 1
Date 1-20-2009
Bill No. SB178



# mill creek generating station

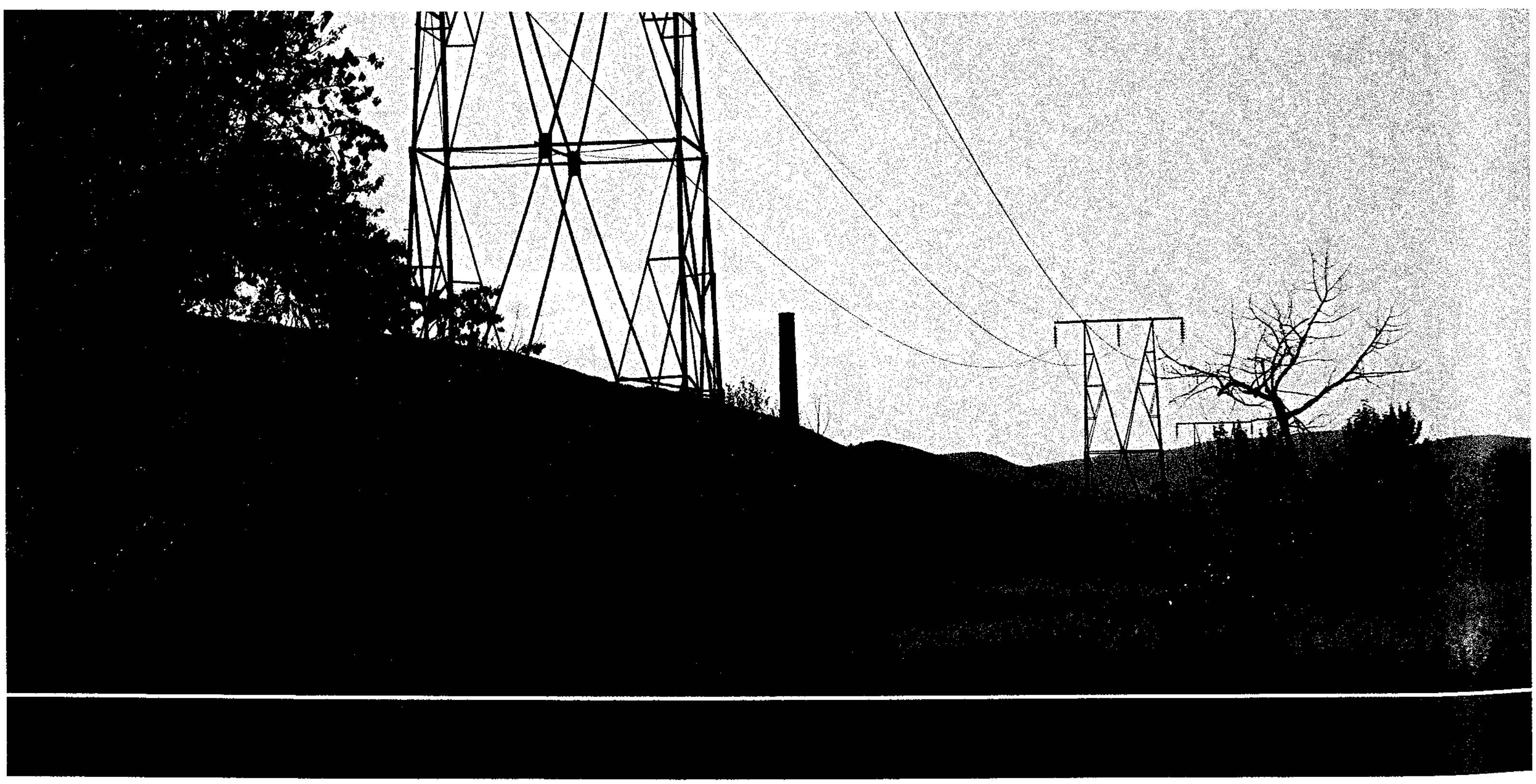
A 200 MEGAWATT NATURAL GAS-FIRED ELECTRIC GENERATING FACILITY


NorthWestern Energy
*Delivering a Bright Future*

40 East Broadway St.
Butte, MT 59701-9394

# contents





# 1 the project

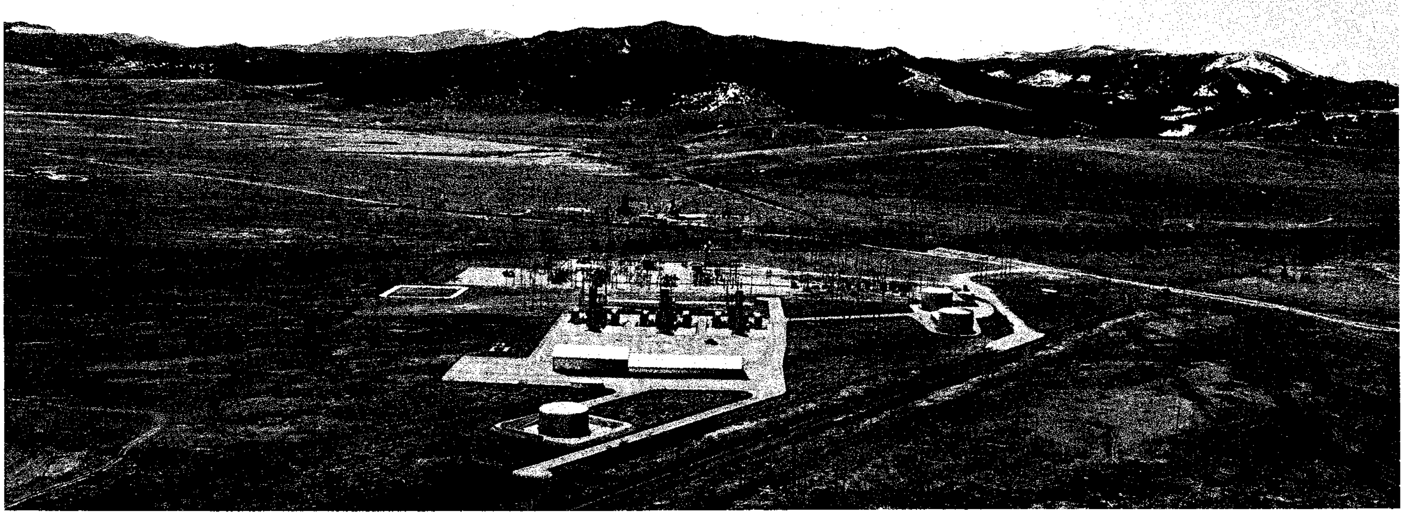
The Mill Creek Generating Station (MCGS) is a proposed 200 megawatt (MW), natural gas-fired electric generation facility. It will use Pratt and Whitney 50 MW FT8 SWIFTPAC® gas turbine generators to provide "regulation service" for NorthWestern Energy's Montana transmission service area, technically referred to as a control area or balancing authority. The project will be constructed in two stages. The first stage will include the erection of three turbine generators by the end of 2010. A fourth unit will be added later, depending upon NorthWestern Energy's need for additional regulation service in Montana.

# 2 project location

The proposed project will be located immediately adjacent the Mill Creek Substation in Section 17, T4N, R10W, Deer Lodge County, approximately three miles east of Anaconda, Montana, on land controlled by NorthWestern Energy. The site is in an industrial area and within a designated Superfund site. NorthWestern Energy's land has already been remediated pursuant to the requirements of U.S. EPA's Record of Decision for the Anaconda Operable Unit. The nearest residential household is approximately 1.5 miles to the northeast, in the unincorporated community of Opportunity. The Bonneville Power Administration has a substation about a quarter-mile southeast of the project site, and S&N Concrete operates a gravel pit and ready-mix plant approximately one-quarter mile to the north. Anaconda-Deer Lodge County owns a 301-acre parcel of land immediately to the southwest where it plans to develop an industrial park. The tracks of the Butte, Anaconda, and Pacific Railway border NorthWestern Energy's land on the south and west. The Silver Lake Pipeline, a 34-inch water supply connecting the watershed west of Anaconda with the City of Butte, crosses NorthWestern Energy's land. Numerous high voltage transmission lines also transect the project area.

Exhibit 1 is an artist's rendering that overlays the proposed generating project on a photograph of the area surrounding the Mill Creek Generating Station.

**exhibit 1** Rendering of Mill Creek Generating Station Project



# 3 types of electric generating facilities

There are three basic types of electric generation plants:

- Baseload
- Peaking
- Regulation

Baseload plants are designed to operate at a fixed capacity in steady state over long periods of time. Typical baseload plants are nuclear, coal-, and oil-fired. Hydroelectric plants can also be used as baseload plants depending on the water supply, storage and seasonality. Peaking plants are designed to operate in fixed increments (power blocks) to meet demand above baseload requirements. Peaking plants are typically operated for several hours at a time during peak periods of energy use. In the western United States, peaking plants are typically natural gas or certain hydroelectric facilities operated to meet peaking needs. "Regulation" service plants are designed to keep the transmission grid in balance by matching electric generation with electric load on the system on a moment-by-moment basis. Regulation service is typically supplied by hydroelectric facilities, if available, and natural gas-fired power plants.

# 4 regulation service

MCGS will operate as a "regulation resource." NorthWestern Energy currently operates its transmission control area (also known as a "balancing authority") in western and central Montana without the benefit of owning any of its own generation. A balancing authority is a transmission system control area operator who must balance electricity supply and loads at all times in order to meet transmission system operating criteria and to provide reliable service to customers. Specifically, NorthWestern Energy must have generating capacity available to it to balance, on a moment-to-moment basis, the differences between resources and loads within its balancing authority.

Historically, the electric "load" on a grid has been considered to be more volatile than the generation side of electrical use. As a result, regulating the transmission system has primarily focused on changes in load. Generation resources that are "dispatchable" (capable of being turned off and on or increased or decreased on demand) require substantially less "regulation" than do intermittent, non-dispatchable resources. Dispatchable resources include coal-fired and hydroelectric generation. Non-dispatchable resources include wind and solar power. Because wind is very difficult to accurately schedule and can be highly volatile on a moment-to-moment basis, it is more problematic to integrate into the transmission grid. For example, at the Judith Gap Wind Farm, the wind farm has ramped up from zero to 131 MW in 10 minutes and has ramped down from 121 MW to zero MW in a similar time period.

The MCGS is needed to stabilize the transmission grid by being able to react to moment-to-moment changes in the difference between load and generation. As a result, the facility must be available 24 hours a day, 365 days per year, with the ability to respond to demand within a few seconds.

# 5 turbine generators

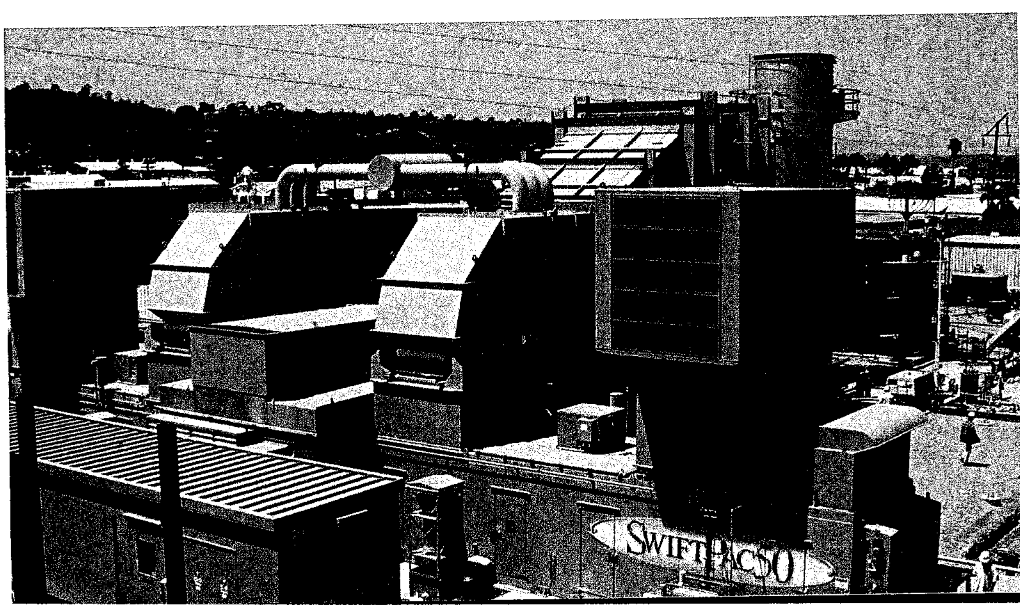
The proposed generation station will initially consist of three combustion turbine generation units operated in simple cycle. A fourth unit will be added later, between 2012 and 2015, based on the need for additional regulation service. Each turbine generator set has a nameplate capacity of approximately 50 MW. The turbines have dual fuel firing capability, burning both natural gas and diesel, and are specifically designed to have a rapid start and ramp rate. The units can be brought on line from a cold start to fully synchronized generation in ten minutes. The units will normally be on to be able to react quickly to system demand. Once in operation, the units can ramp up or down at a rate of at least 15 MW per minute. NorthWestern Energy has selected the Pratt and Whitney FT8 SWIFTPAC® turbine generator as the preferred choice of technology for the project. The FT8 SWIFTPAC® gas turbine is derived from an aircraft engine that has been extensively used on commercial airliners where it has logged millions of flight hours with a high reliability rating. The FT8 SWIFTPAC® is well tested, proven turbine technology.

Each SWIFTPAC® consists of two simple cycle combustion turbines connected by a shaft to a single generator. Within each combustion turbine unit (2 per SWIFTPAC®), air is compressed in the compressor, mixed with fuel and water, and then fired in the combustor to produce hot, compressed combustion gases. Expansion of these gases in the turbine rotates the turbine shaft, which turns a generator to produce electricity. Each of the SWIFTPAC® units is rated at 50 MW for a facility-wide year 2010 total capacity of 150 MW to be used for regulation service. The use of the rapid-ramping SWIFTPAC® is ideal for the anticipated variable operating conditions of the MCGS, which is intended to offset the continuous variation between system generation and system load particularly when intermittent wind generation turbine profiling is expected to make up an increasing share of NorthWestern Energy's retail electricity supply portfolio.

Each unit is approximately 120 feet wide, 120 feet long and 30 feet high. Exhibit 2 is a photograph of the Pratt and Whitney SWIFTPAC® turbine generator.

**exhibit 2** Pratt and Whitney SWIFTPAC® Turbine Generator with SCR Emission Contr

El Cajon, California



# 6 other facilities

In addition to the turbine generators, the MCGS will include:

**a** A combination office, maintenance building;

**b** Storage of up to 20,000 gallons of 19% aqueous ammonia in one or two tanks — the ammonia is used in the emission control equipment;

**c** Up to two 1 million–gallon diesel fuel tanks;

**d** A rail spur;

**e** A bank of transformers to step up the voltage of the power as it leaves the generating unit;

**f** A short span of transmission cabling to tie the generating station to the Mill Creek Substation;

**g** Two 500,000-gallon water storage tanks for raw and demineralized water; and

**h** A sewer line linked to Anaconda's wastewater treatment plant.

# 7 fuel supply

The natural gas used in the turbine generators will be obtained from an existing NorthWestern Energy pipeline running between Morel, which is about a mile north of Warm Springs, and Anaconda. A new line approximately 2.5 miles long will be constructed to the plant from that line. Sources of natural gas transmitted in the pipeline include gas fields in northern Montana and Canada. In order to maintain the correct pressure of the natural gas, a compressor station will be located about 2.5 miles from the facility near State Highway 48 between Anaconda and Warm Springs.

The Mill Creek plant will also be permitted to use diesel as an alternative fuel source for up to thirty (30) days per year, as a back-up to the interruptible natural gas source. It is anticipated the diesel will be acquired directly from Montana refineries and transported to the MCGS site via railroad tanker car.

Biodiesel may be used in the future, when its use is certified by the turbine generator manufacturer and it is cost competitive with petroleum-based diesel.

Exhibit 3 on the following page contains a schematic drawing showing the component elements of the turbine generator units.

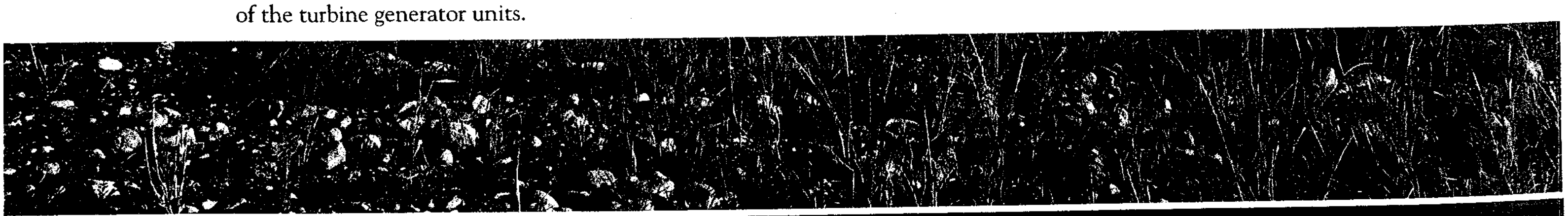
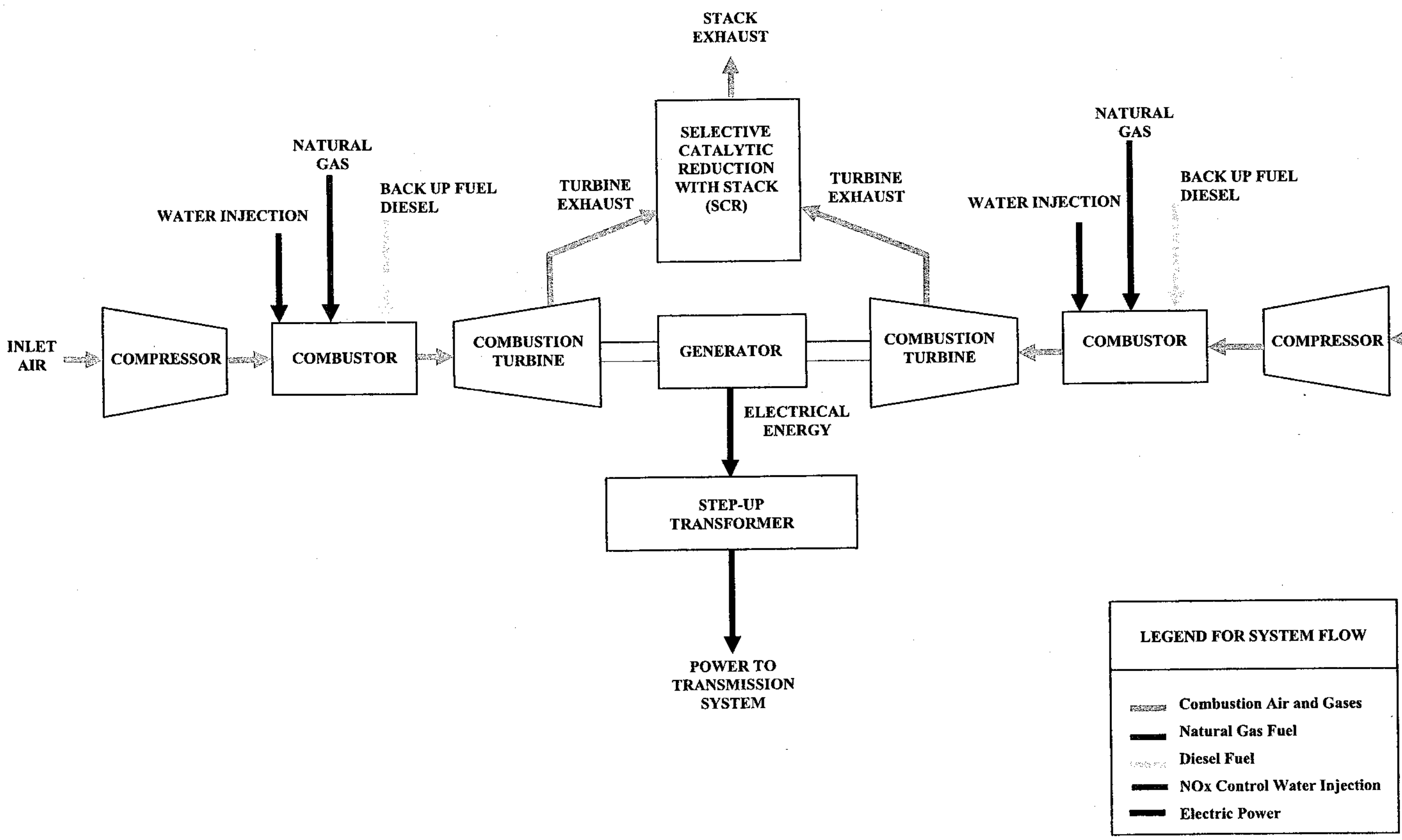


**exhibit 3** Pratt & Whitney FT8 Simple Cycle Combustion Turbine Generator Unit



# 8 water supply and sewer

Water for the MCGS will come from the Silver Lake pipeline, a 34-inch diameter line that carries water from areas west of Anaconda to Butte. The pipeline crosses the southern end of NorthWestern Energy's Mill Creek property. Approximately 600 feet of small-diameter pipeline will be constructed to bring water into the generating plant where it will be stored in a 500,000-gallon raw water storage tank. From there, the water will be filtered in a reverse osmosis unit to remove dissolved minerals and then stored in a 500,000-gallon demineralized water tank. The plant will use approximately 60,000 gallons per day (gpd) average, with 250,000 gpd maximum.

Wastewater produced at the plant will primarily consist of reject from the reverse osmosis units used to produce demineralized water for use in the turbines and air quality pollution control equipment. Wastewater will be transported to the City of Anaconda's wastewater treatment plant via sewer line. The wastewater treatment plant is approximately two miles west of the project site, near the intersection of Montana Highway 1 and Highway 48. MCGS is expected to produce about 15,000 gpd average, and 40,000 gallons of wastewater per day maximum.

On August 13, 2008, Anaconda-Deer Lodge County (ADLC) enacted a Tax Increment Financing District (TIFD) in the Mill Creek area to finance the construction of infrastructure to serve the Mill Creek area, including the sewer line to the wastewater treatment plant. ADLC is planning to develop a 300-acre industrial park immediately southwest of the MCGS site.

# 9 emission control systems

Nitrogen oxide ($NO_X$) emissions from each turbine will be controlled using a Selective Catalytic Reduction (SCR) emission control device prior to being emitted to the atmosphere. Demineralized water is injected into the turbines to assist with $NO_X$ control. In addition, carbon monoxide (CO) emissions from each turbine will be controlled using a catalytic oxidizer system. Emissions from each SWIFTPAC® will exhaust through a separate stack with a diameter of approximately 15 feet and a height of approximately 90 feet.

The estimated fuel consumption for the plant is approximately 3,500 million standard cubic feet (MMscf) per year of natural gas and approximately 2 million gallons per year of ultra low sulfur fuel oil #2. Exhibit 4 shows the expected annual air emissions from the plant compared with emissions from the Anaconda Smelter prior to its closure in the early 1980s.

## exhibit 4 Annual Emissions Comparisons

**Annual Emmision Comparisons**

NorthWestern Energy

Mill Creek Generating Station

Pratt & Whitney Power Systems FT8 SWIFTPAC® 50

| Pollutant | tons per year<br>Anaconda Smelter | tons per year<br>Mill Creek Gen. Station | MCGS Comparison | Notes |
|---|---|---|---|---|
| Sulfur Dioxide (SO2) | 281,750 | 14 | 0.0050% | a, b |
| Oxides of Nitrogen ($NO_X$) | 67,747 | 186 | 0.27% | a, c |
| Carbon Monoxide (CO) | 5,007 | 47 | 0.94% | a,c |
| Particulates (PM, $PM_{10}$) | 4,780 | 211 | 4.4% | a,b |
| Volatile Organics (VOC) | no data reported | 26 | N/A | a |
| Lead (Pb) | no data reported | 0.0086 | N/A | a |

**Notes**

a. All MCGS emissions are maximum potential emissions from application for air quality permit

b. Anaconda Smelter $SO_2$ and Particulate from 1977 emissions estimate

c. Anaconda Smelter $NO_X$ and CO from 1975 county-wide estimate (stack emissions only)

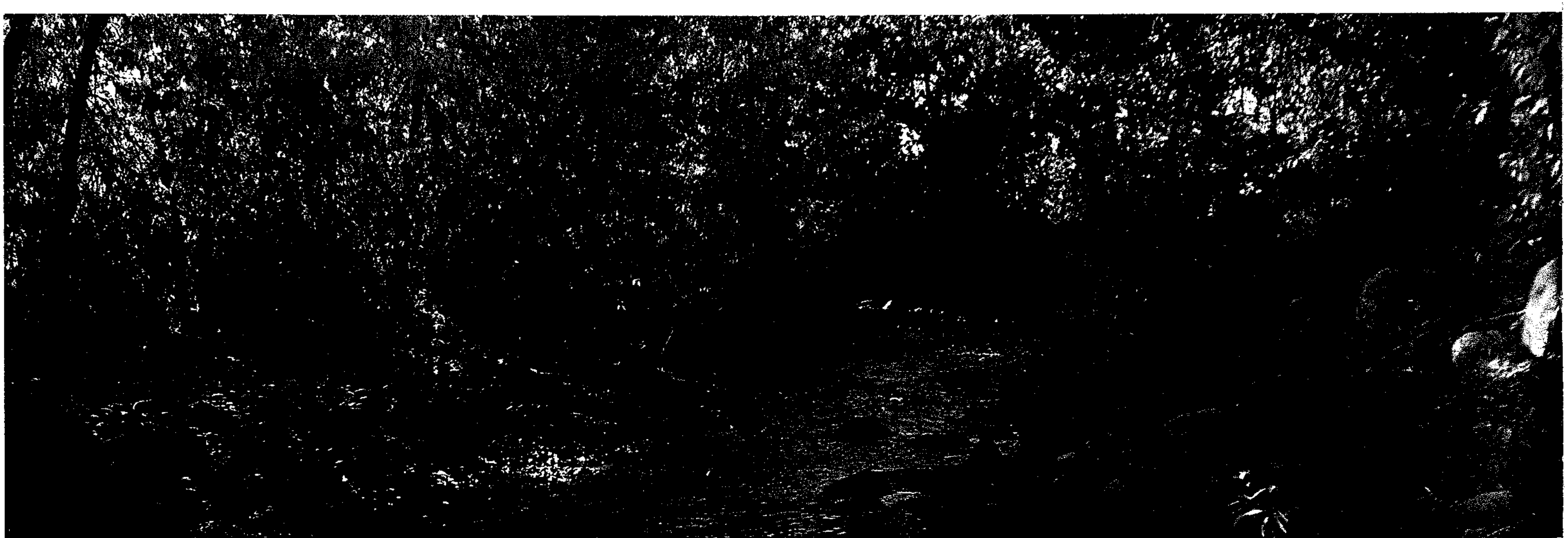
The generating plant will comply with all local, state and federal environmental regulations. All necessary permits, licenses, and authorizations will be acquired before construction will proceed.

# 10 audible sound

The combustion turbine generating units are designed to meet industry standards for audible sound. Exhibit 5 shows the project sound levels of the MCGS and compares those levels with other common sounds in the environment.

## exhibit 5 Audible Sound Levels

| Decibel Level | Source/Distance |
|---|---|
| 140 dBA | Firearm @ 3 feet |
| 130 dBA | Jackhammer |
| 110 dBA | Power saw @ 3 feet |
| **91 dBA** | **MCGS (maximum) @ 3 feet** |
| 90 dBA | Truck traffic |
| **70 dBA** | **MCGS (maximum) @ 400 feet** |
| **65 dBA** | **MCGS (maximum) @ .25 mile** |
| 60-70 dBA | Normal Conversation @ 3-5 feet |
| **58 dBA** | **MCGS @ 1.5 miles (Opportunity and Aspen Hills Subdivision)** |
| 30 dBA | Whisper, quiet library |



# 11 economic impact

The MCGS project will employ up to 75 people during construction and 11 people during operation of the facility. Annual operating wage and employee benefit expenditures for the plant (after construction) will be about $1.6 million per year.

The projected capital cost of the project is $206.1 million, and the plant will pay approximately $8.0 million in property taxes annually given existing state and local tax levies. The project will have an operating life of between 30 and 40 years.

As a rate regulated cost of service public utility, the cost of constructing and operating the plant will be included in customer rates. MCGS will be privately funded by NorthWestern Energy.

NorthWestern™
Energy

***Delivering a Bright Future***

**SB 178**

## Comparison of Contract Costs in NorthWestern Energy's Electricity Supply Portfolio in 2008

### Average Cost of Electricity (Residential Customer)

$60.21 per MWH

| Average Cost of Contracts Negotiated by NorthWestern | Average Cost of Governmentally Mandated Contracts (QFs) |
|---|---|
| $53.99 MWH<br>(Energy, capacity, integration, administration) | $88.83 MWH<br>(Energy) |

### Contracts vs. NorthWestern Cost

QF Contracts are 64.5% more expensive

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**SB 178**
**Types of Electric Generating Resources**

**Dispatchable Generating Plant**

| Type | Principal Use |
| --- | --- |
| Nuclear | Baseload |
| Coal | Baseload |
| Hydroelectric | Baseload/Peaking/Regulation |
| Combined Cycle Gas | Baseload |
| Simple Cycle Gas | Peaking/Regulation |
| Biomass | Baseload/Peaking |
| Geothermal | Baseload/Peaking |

**Non-Dispatchable Generating Plants**

| | |
| --- | --- |
| Wind | Supplements Baseload |
| Solar | Supplements Baseload |
| Hydroelectric (Canal/Pipeline) | Baseload |
| Wave | Supplements Baseload |

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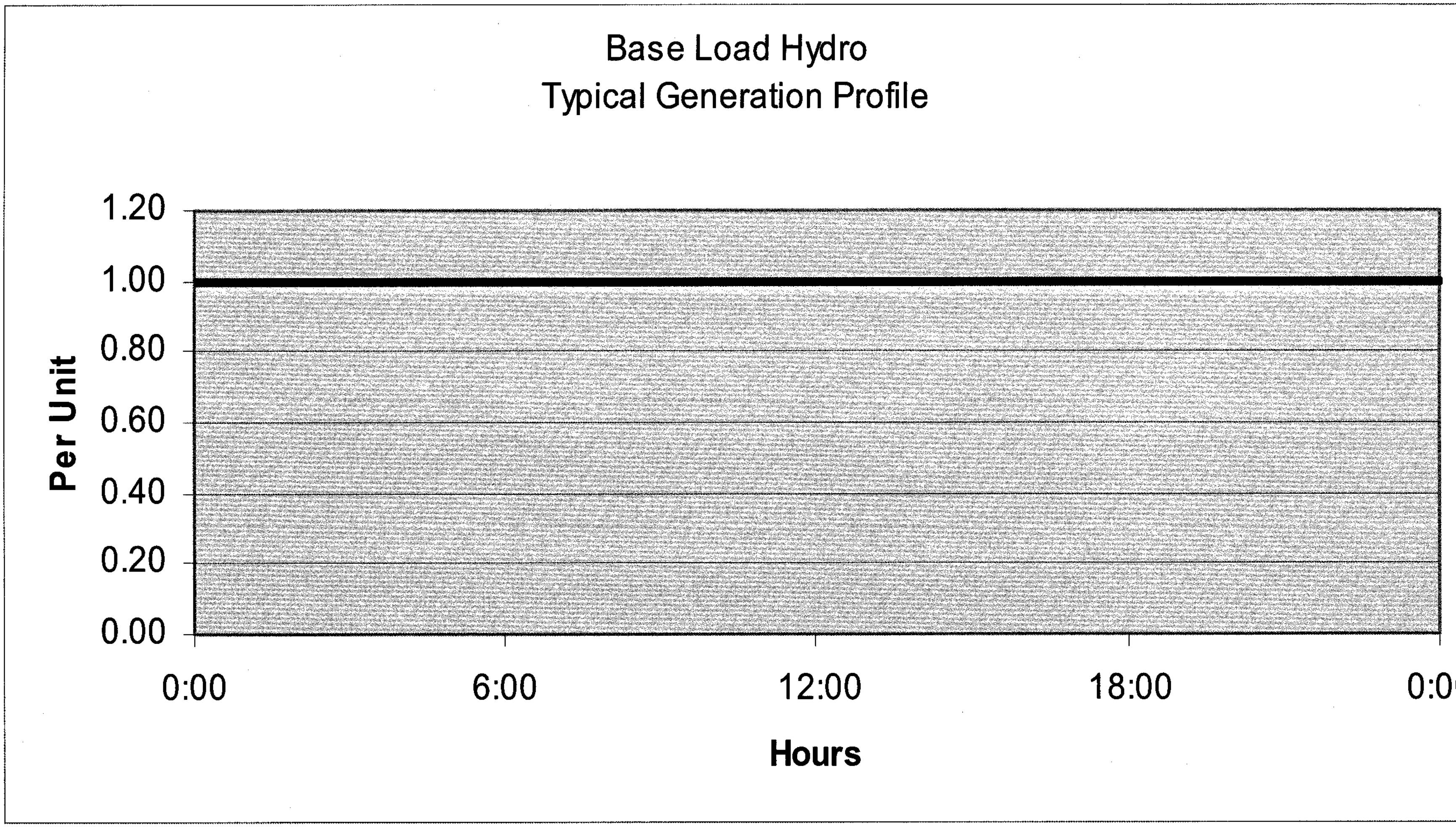
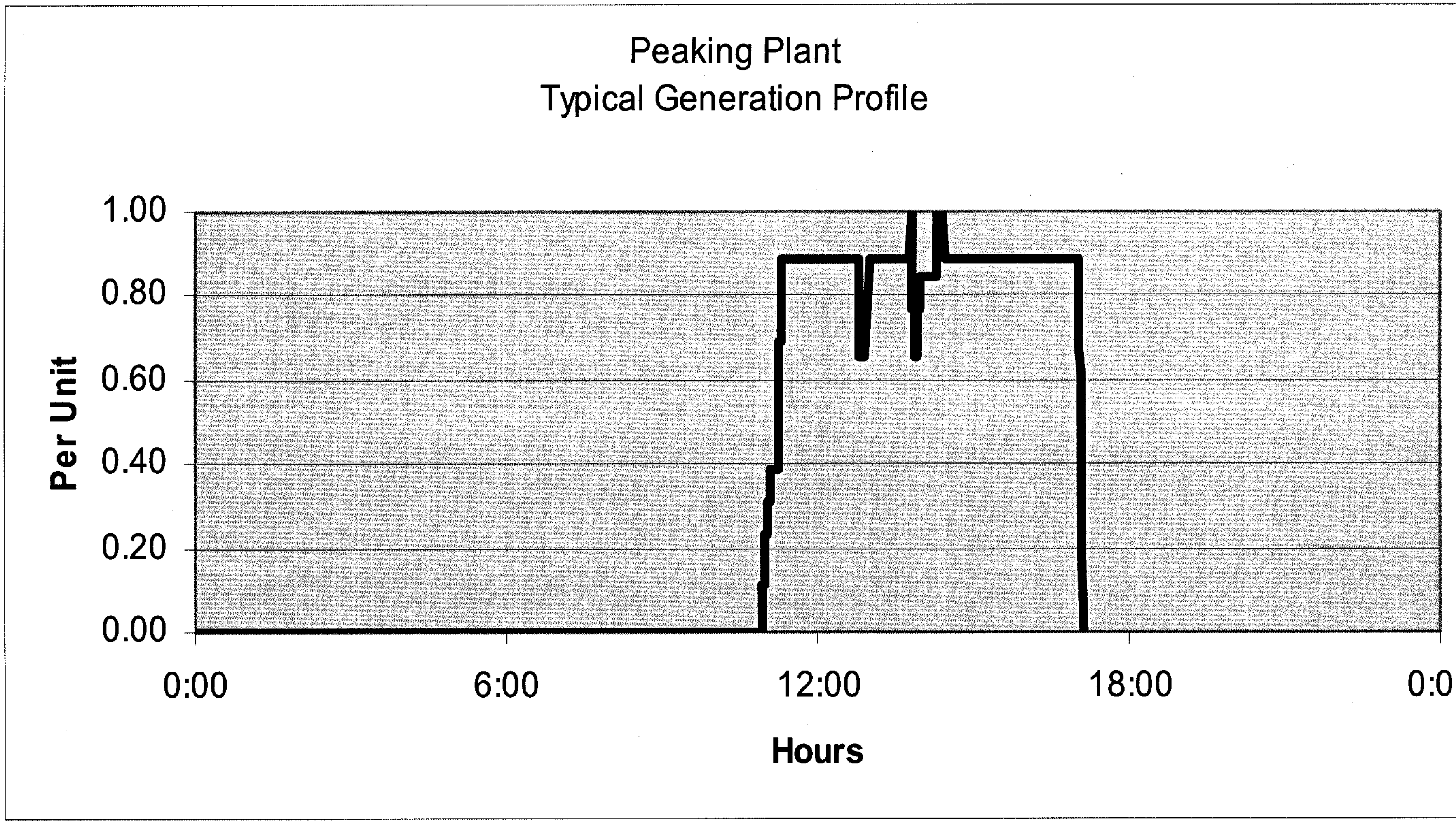
# June 15, 2007



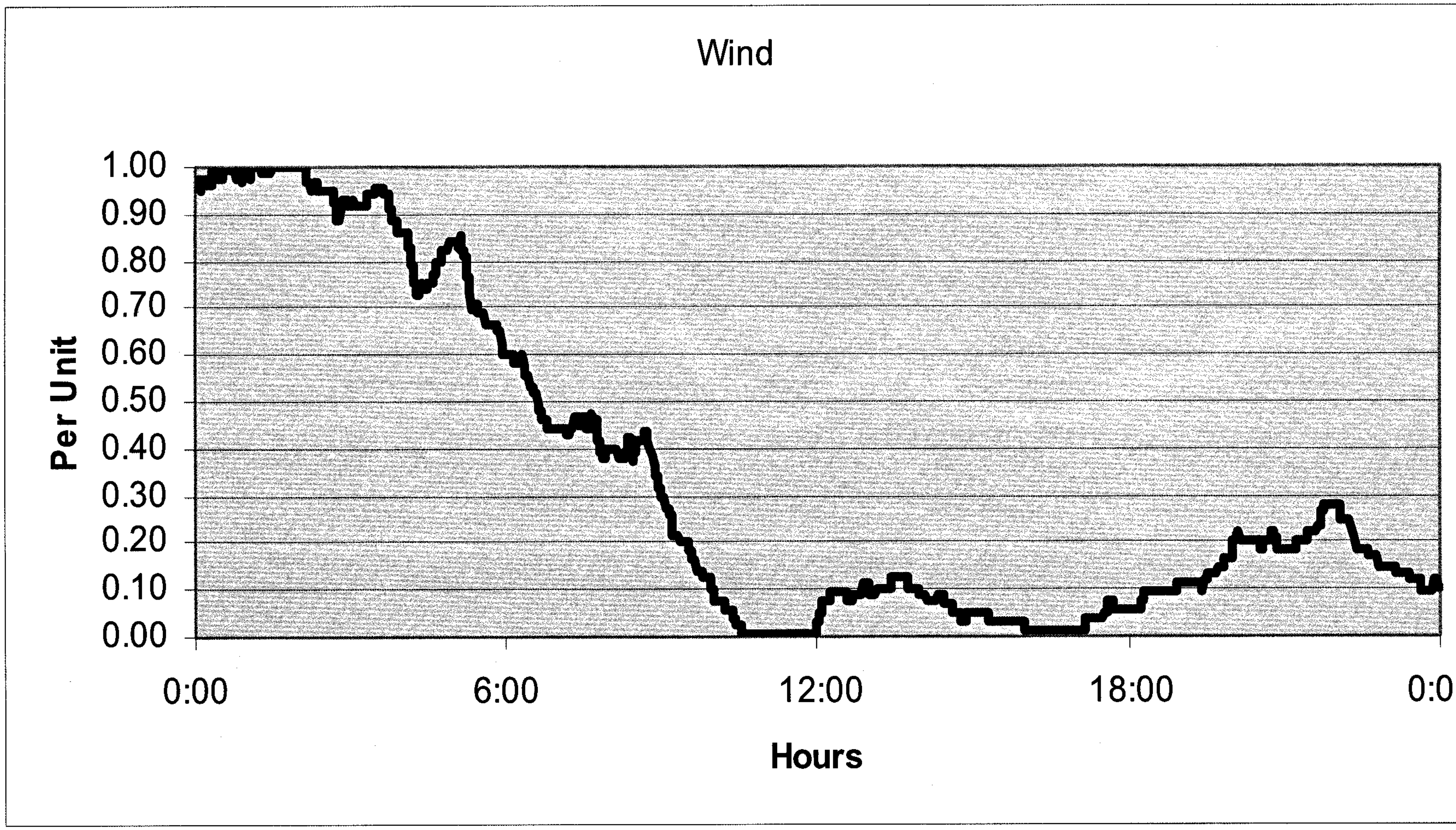
Base Load Hydro
Typical Generation Profile
Per Unit
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0:00
6:00
12:00
18:00
0:00
Hours

# June 15, 2007



Peaking Plant
Typical Generation Profile
1.00
0.80
0.60
0.40
0.20
0.00
Per Unit
0:00
6:00
12:00
18:00
0:00
Hours

# June 15, 2007

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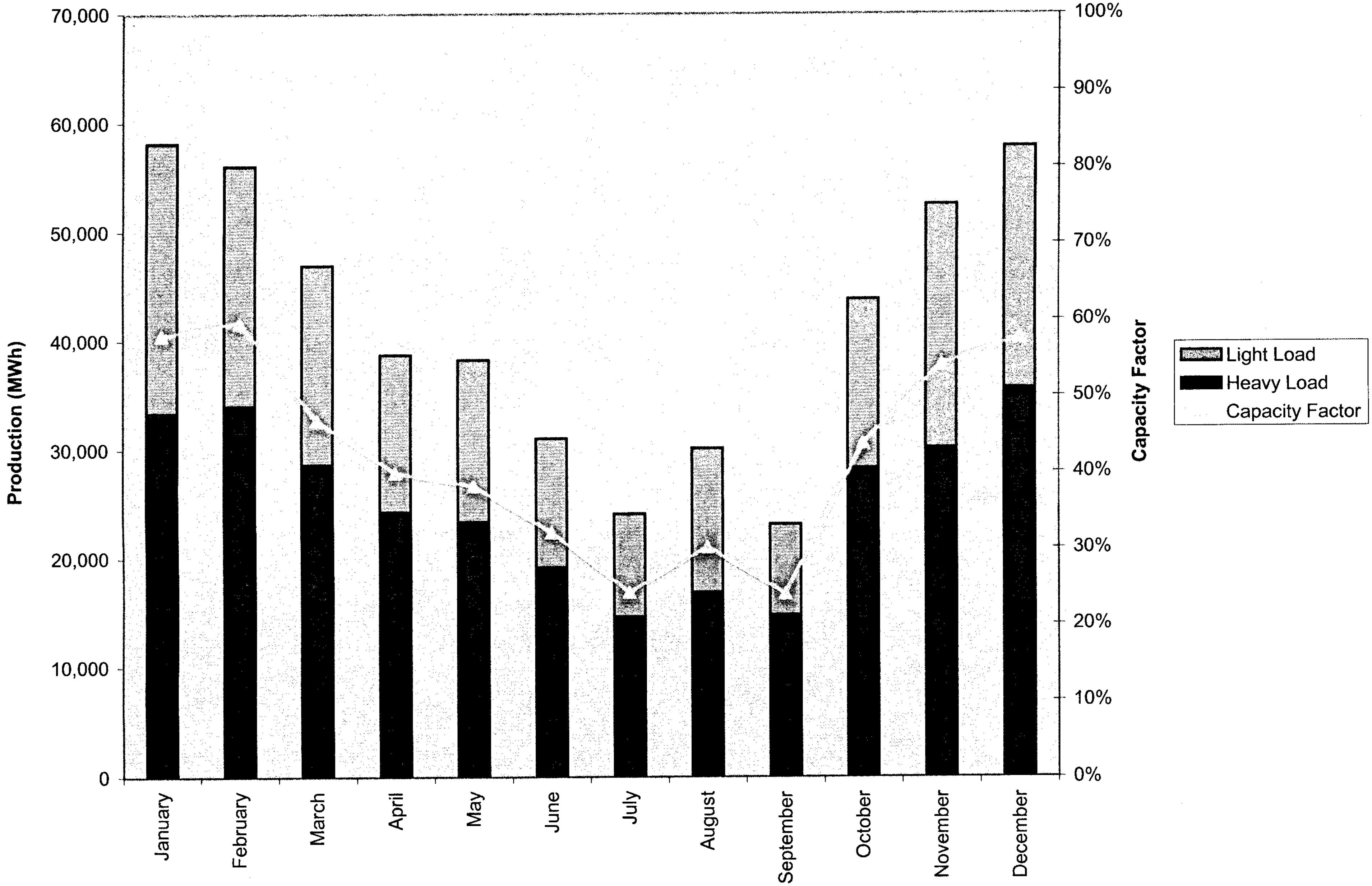
Delivering a Bright Future

# Wind Energy
# 2008 Production Summary

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**SB 178**
**The Seasonal Price of Electricity**
**NorthWestern Power Market Mid-C (1)**
**Dollars Per Megawatt Hour**

| Year | Winter January-March | Spring April-June | Summer July-September | Fall October-December |
|---|---|---|---|---|
| 2006 | $46.57 | $22.57 | $50.46 | $52.12 |
| 2007 | $45.08 | $43.81 | $49.01 | $57.24 |
| 2008 | $68.99 | $49.06 | $56.98 | $48.43 |
| 3-Year Average | $53.55 | $38.48 | $52.15 | $52.60 |
| Off-Peak - Peak Range | | | | |

(1) Weighted average of heavy and light load.

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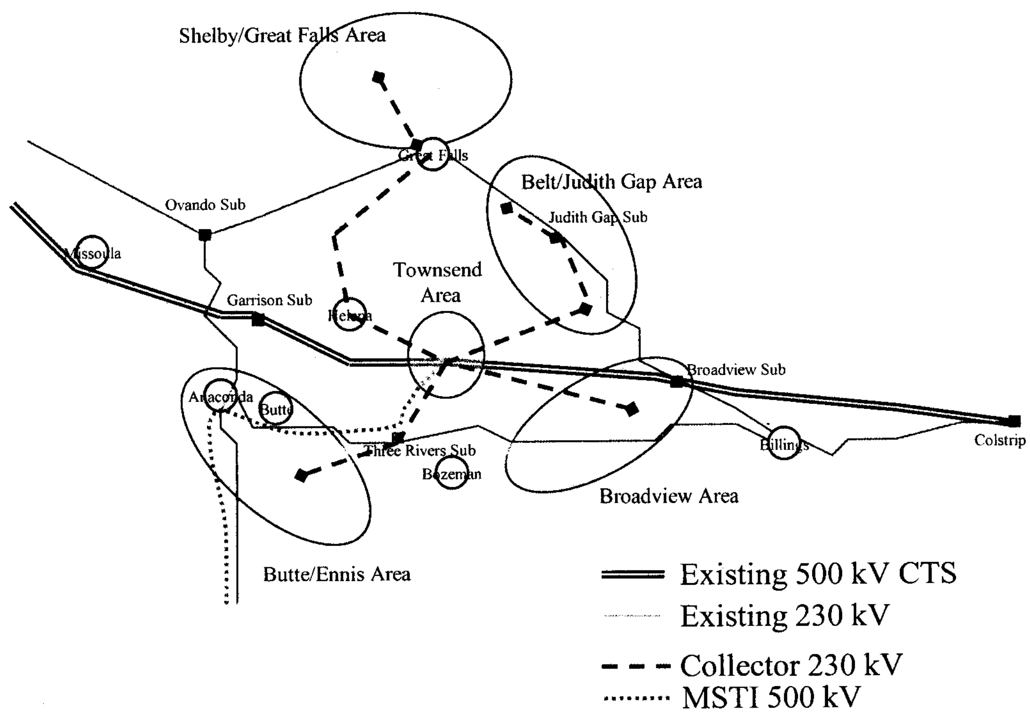
# Collector System Example




Jan 20, 2009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# POWER

BUSINESS AND TECHNOLOGY FOR THE GLOBAL GENERATION INDUSTRY

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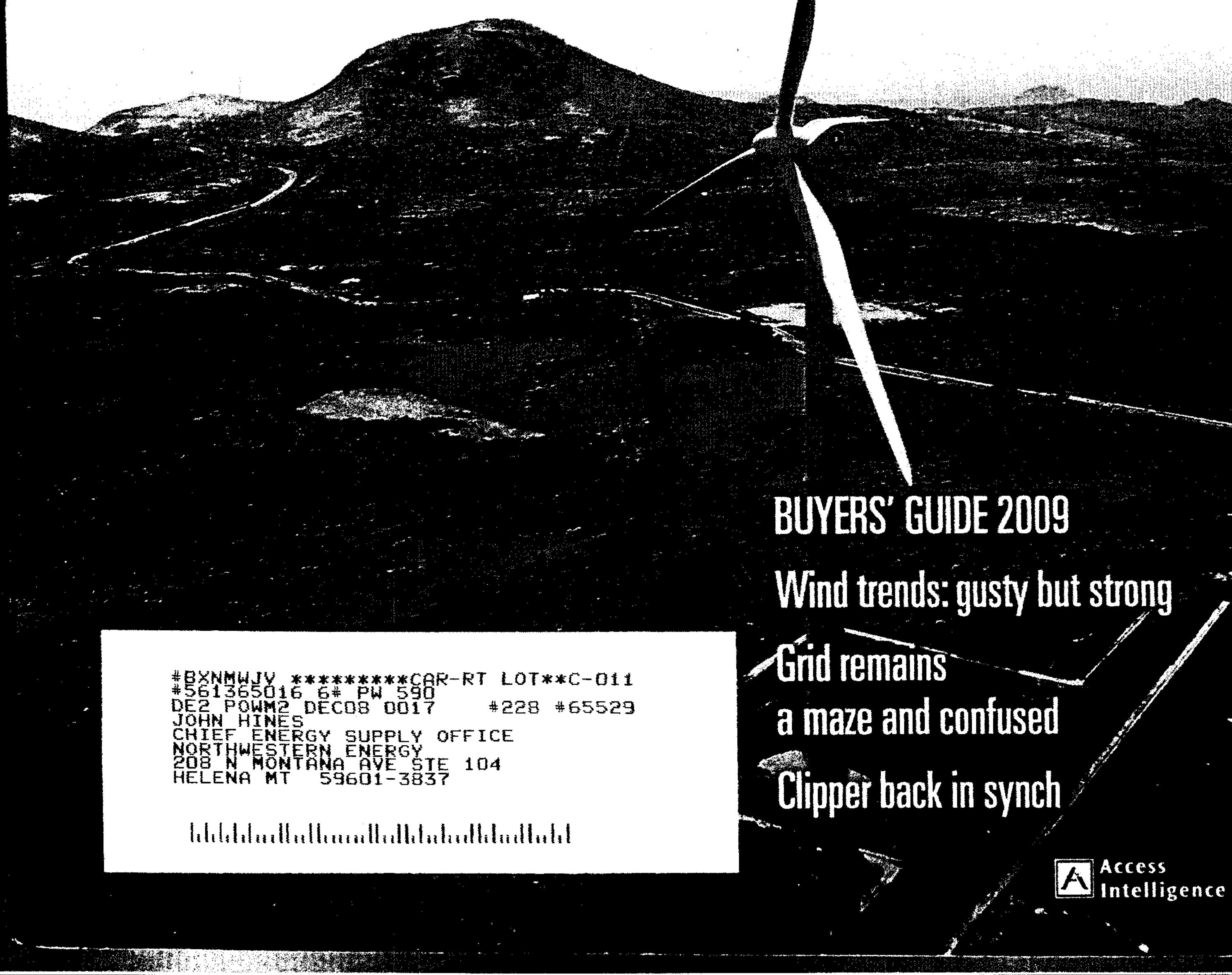
## Top Plants: Five winning renewable projects



BUYERS' GUIDE 2009

Wind trends: gusty but strong

Grid remains a maze and confused

Clipper back in synch

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Access Intelligence

# Thermo Plant, Beaver County, Utah

**Owner/Operator: Raser Technologies**

Geothermal energy projects are gaining steam in many parts of the western U.S., in large part because geothermal power has the advantage of being a renewable energy source that provides baseload power with no emissions and no waste by-products. One example of the latest developments in geothermal power generation is the recently completed 10-MW geothermal plant in rural Utah, which uses innovative modular power generation units.

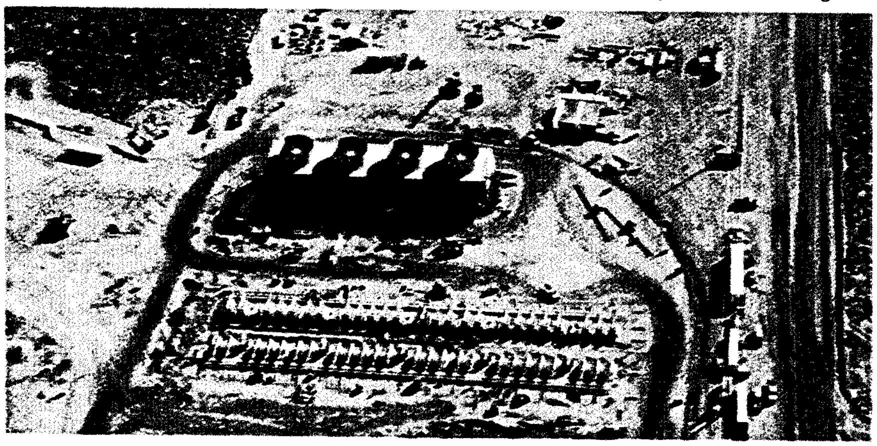
**By Angela Neville, JD**

The U.S. continues to be one of the lead countries in the booming geothermal power market, according to the Geothermal Energy Association (GEA). Today the U.S. is the world leader in on-line geothermal energy capacity, producing 30% of the worldwide total.

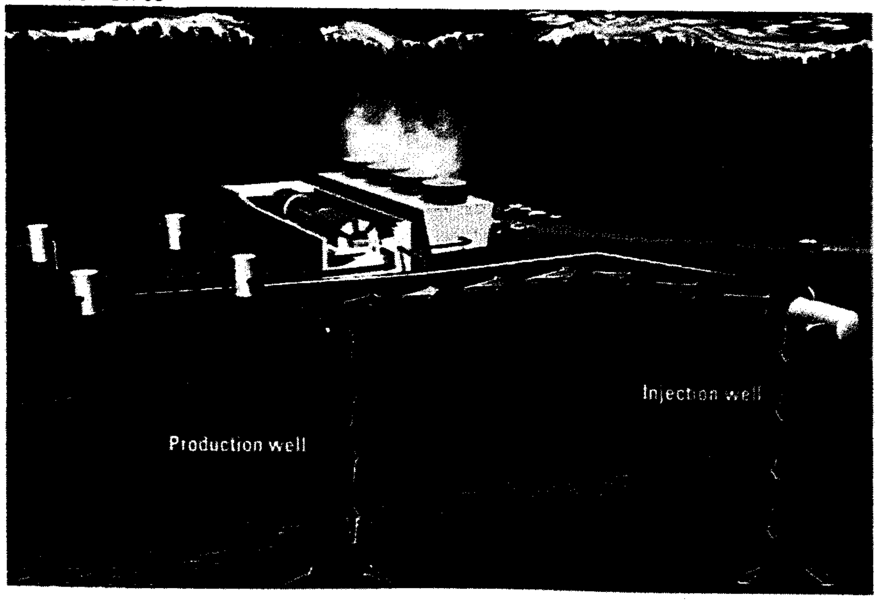
Electricity is currently generated from geothermal energy in seven U.S. states: Alaska, California, Hawaii, Nevada, New Mexico, Utah, and Idaho. Other states, such as Oregon and Wyoming, are soon to be added to the list. As of August 2008, the GEA estimated that the U.S. had a total installed capacity of 2,957.94 MW of electricity generated by geothermal power.

More capacity is being added to that total with the introduction of the Thermo Plant in Beaver County, Utah, which is designed to produce 14 MW of gross electrical power (approximately 10 to 11 MW net) once it becomes operational toward the end of this year. It is the first commercial geothermal power plant built in Utah after a hiatus of more than two decades (Figure 1).

**1. Some like it hot.** This aerial view shows the completed geothermal plant. The power generation units were manufactured off-site and then transported to the Thermo Plant site, where they were connected to the wells and cooling towers. *Courtesy: Raser Technologies*



**2. Subterranean sizzle.** In a geothermal power plant, hot water from underground reservoirs shoots up a production well, provides heat or steam to power a turbine/generator, and then is returned to the reservoir through an injection well. *Source: Geothermal Education Office*

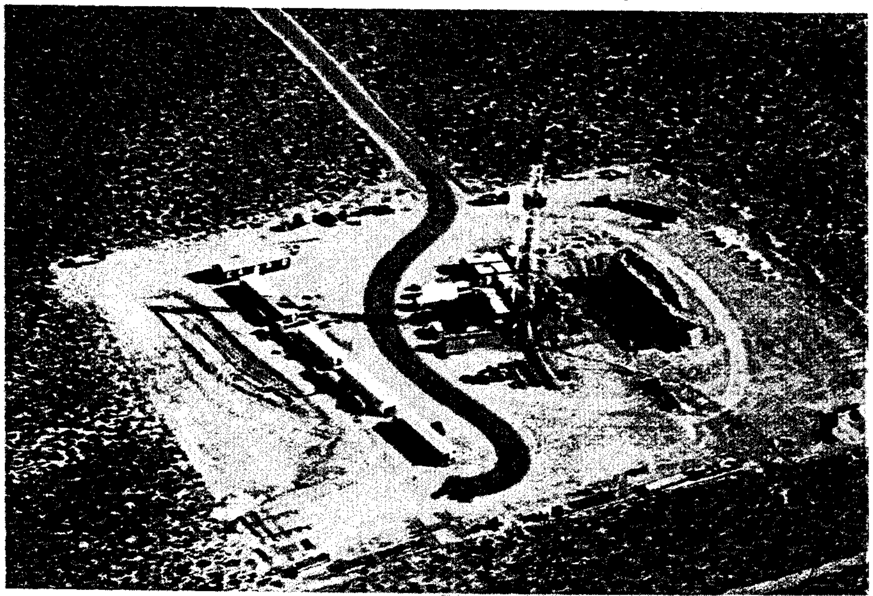



## Hot rocks are hot business

To develop electricity from geothermal resources, wells are drilled into the naturally hot fluids that are known as geothermal reservoirs, which are created by heat emanating from Earth's interior (Figure 2). These reservoirs are composed of underground areas of cracked and porous hot rocks saturated with hot water, which sometimes can reach temperatures of 500F or higher.

On Oct. 22, the U.S. Department of the Interior (DOI) announced that it plans to make more than 190 million acres of federal land in 12 western states available for geothermal energy development. The DOI's Final Geothermal Programmatic Environ-

**3. Drill, baby, drill.** The drilling rig completed the geothermal wells that provide heated water to power the plant's binary cycle. *Courtesy: Raser Technologies*



mental Impact Statement identifies 118 million acres of public lands managed by the Bureau of Land Management and 79 million acres of National Forest System lands that could be opened to future geothermal leasing. The DOI speculates that this new development potentially could lead to 5,540 MW of additional geothermal power capacity by 2015.

The DOI's estimates of potential geothermal power production may actually be low, according to the U.S. Geological Survey (USGS). In late September, the USGS released its first assessment of geothermal resources in more than 30 years. The study found that identified geothermal resources in the western U.S. could produce 9,057 MW of power, while another 30,033 MW of power could be generated from conventional geothermal resources that have not yet been discovered. According to the agency's study, the use of a new technology—called enhanced geothermal systems, which involves creating or expanding a geothermal resource through the high-pressure injection of a fluid—makes yet another 517,800 MW possible.

Because some renewable energy sources can only operate under favorable weather conditions, they are often considered to be limited in their ability to meet the looming large-scale power needs of this century, according to the GEA. Geothermal plants, however, have the potential to provide reliable sources of electricity while offering significantly lower emissions levels than fossil fuel sources and avoiding problems of radioactive waste disposal. Unlike wind and solar energy, geothermal energy is a readily available, constant source of heat or steam for power generation and is therefore considered a baseload resource, as are coal, oil, natural gas, and nuclear.

In October, *POWER* interviewed Brent M. Cook, CEO of Raser Technologies, about both general trends in the U.S. geothermal industry and the company's new geothermal plant in Utah.

"Wind and solar power are considered intermittent power—meaning that they produce power only when the wind is blowing or the sun is shining," he said. "Both only are available about 30% to 35% of the time. You have to build roughly three times the capacity in wind and solar as geothermal to produce the same amount of megawatt-hours. While wind is cheaper to build on a megawatt basis, it is much more costly on a megawatt-hour basis than geothermal. Coal and natural gas also are cheaper as far as the cost of construction goes compared to geothermal; however, if you take into account the cost of fuel and the cost of carbon emissions, geothermal is cheaper."

## Plant profile

Cook told *POWER* that the Thermo Plant already had begun the commissioning process in October and was expected to complete it by late November or early December. The plant will generate electricity during commissioning. Once it is officially commissioned, it will start running 100% of the time.

Raser Technologies settled on the plant's location in Beaver County, Utah, for a number of reasons:

- There was an existing production well that indicated sufficient heat and fluid flow to produce geothermal power using binary-cycle technology.
- It was located on private lands, making land acquisition and permitting easier.
- It was situated relatively close to the grid, so connecting to the grid would be less costly.

Raser Technologies also has lined up a customer to purchase the electricity that will be produced once the geothermal plant become operational. "We signed a 20-year power purchase agreement with the city of Anaheim, California," Cook said. "They will pick up the power in Beaver County and take it to California. Because this is a renewable energy source, they get credit for meeting the required portfolio standard that the state of California has in place."

Unlike some renewable power generation facilities, the Thermo Plant does not have a problem with grid access. "We built about six miles of transmission lines to connect to the grid," Cook said. "We have not experienced any interconnectivity issues to date."

## Plant construction phase

Raser Technologies sought permitting for the geothermal plant on both state and county levels. According to Cook, the plant will also be regulated by the utility industry to a certain extent. He said that the plant's developers did not face any unusual regulatory hurdles.

"Construction costs will be approximately $35 million," Cook said. "Thermo will receive $26 million of debt financing and $25 million of tax equity capital. Both are funded by Merrill Lynch."

Utah has a small production tax credit (PTC) that will accrue with the power generation, according to Cook. The plant also will qualify for the federal PTC.

The Thermo Plant set a record for the speed of its construction, according to the Raser Technologies executive (Figure 3). "This is the first time that a commercial geothermal power plant has been built in less than six months," he said. "We broke ground in May 2008 and will have a ribbon-cutting ceremony later this month—October 2008."

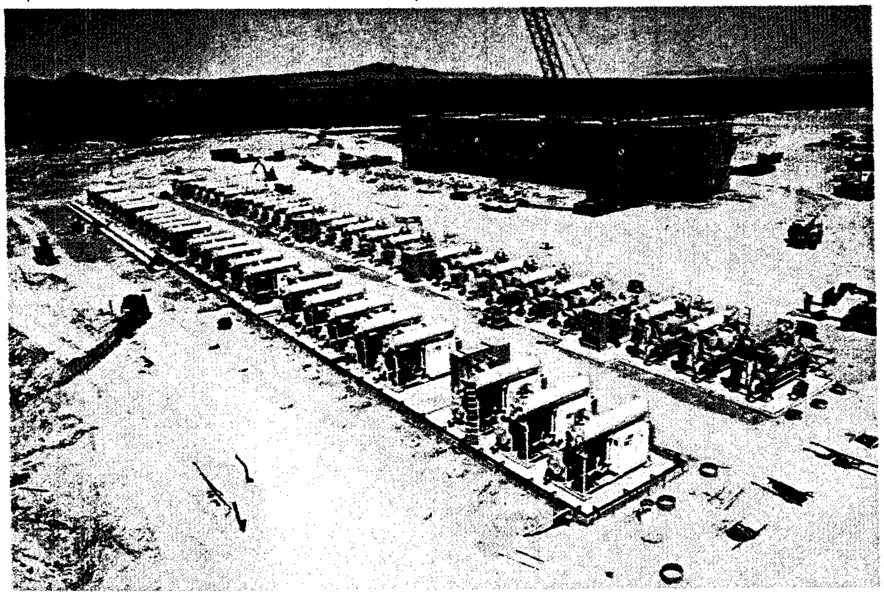
The company's unique rapid deployment strategy, according to Cook, utilizes UTC power generating units that are manufactured off-site and shipped to the project ready to be hooked up and operated (Figure 4). The 10-MW facility combined 50 modular, low-temperature PureCycle power units from UTC Power, allowing power plant construction to be completed in just a few months. These turbine-generator modules function as small individual power plants. Thermo is the first commercial-scale project to use the UTC units and will act as a template for developing a number of cookie-cutter 10-MW projects in a rapid deployment fashion.

UTC Power's geothermal power system was recognized in 2007 by *R&D Magazine* as one of the 100 most technologically significant products introduced during the prior year. This new breakthrough technology offers the following advantages:

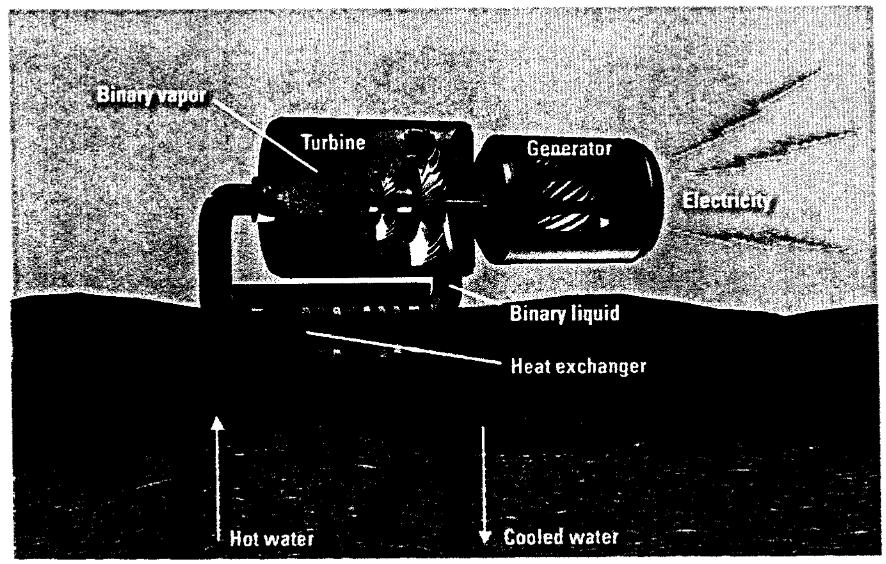
- It is premanufactured for economy in high volume.
- It can be delivered and deployed rapidly, avoiding costly on-site engineering delays.
- Its flexible modular design enables multiple units to be connected into larger power generation "farms."

Once the plant is on-line, a minimal staff will handle simple maintenance operations, according to Cook. Raser has a guarantee from UTC that the manufacturer will maintain the generation units on an ongoing basis.

**4. Fast-tracking construction.** The entire 10-MW geothermal Thermo Plant was designed around 50 UTC PureCycle power generation units. This picture shows them arranged in pods of five and two rows of 25. *Courtesy: Raser Technologies*



**5. Playing a supporting role.** In the binary-cycle process, geothermal water is used only for its heat, not to produce steam. In a heat exchanger, the water's heat transfers to a second fluid, which flashes to vapor and drives the turbine. *Source: Geothermal Education Office*




## Using the binary-cycle process

Generating facilities powered by very hot geothermal reservoirs of about 350F or higher are called flash steam plants. But the water temperature in the geothermal reservoir at the Thermo Plant site is not high enough to produce steam with the pressure needed to efficiently turn a turbine-generator. Because of its lower water temperature, the Thermo Plant will utilize binary-cycle technology, Cook said.

In the binary-cycle process, geothermal water heats another liquid, such as isobutane, which boils at a lower temperature than water. The two liquids are kept completely separate through a heat exchanger that is used to transfer heat energy from the geothermal water to the "working fluid." The secondary fluid vaporizes into a gaseous vapor and, as with steam, the force of the expanding vapor turns the turbines that power the generators. According to Cook, the second liquid used at the Thermo Plant is "RU134—UTC refrigerant."

With the binary-cycle process, water from the geothermal reservoir well remains in a closed loop and never comes in direct contact with the surface land, air, or turbines. It is returned to the well unchanged and uncontaminated. Because of this, binary plants operate with little or no emissions or greenhouse gases (Figure 5). According to the GEA, such recent advances in geothermal technology have made possible the economic production of electricity from lower-temperature geothermal resources, at 212F to 302F.

## Charting a future course

The folks at Raser Technologies are optimistic about the outlook for geothermal energy in the U.S. "I would again refer you to the number of studies that have been done by USGS, the DOE and MIT," Cook said. "Because geothermal is baseload, it has the ability to become a significant portion of the nation's overall energy plan. Their studies show that geothermal can be 10% to 20% of the nation's overall energy production."

His upbeat attitude extends to his expectations about the future of the Thermo Plant. He pointed out that recent analysis of overall resources at the Thermo location indicates that it has potentially more than 230 MW of additional geothermal resources. Raser Technologies believes that there will continue to be a number of construction and drilling jobs on the site for several years to come as it further develops and builds additional geothermal plants.

When asked for his estimate of the long-term production potential of production wells at the Thermo Plant, Cook responded, "The UTC units are built to last 35-plus years. The geothermal fluids are engineered to last at least 10,000 years." ■